Research Problem Review 78-14

LEVEL II

HUMAN FACTORS EVALUATION OF A HELIBORNE ELECTRONIC WARFARE SYSTEM (AN/ALQ-151, QUICK FIX)

Edwin R. Smutz

FORT HOOD FIELD UNIT

U. S. Army
Research Institute for the Behavioral and Social Sciences

August 1978

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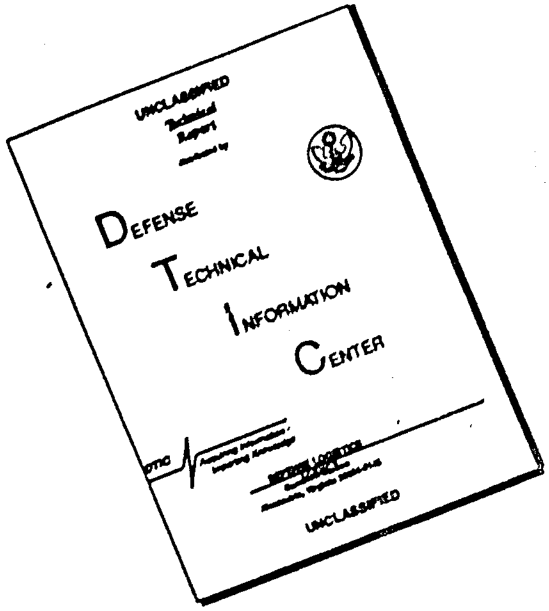

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HUMAN FACTORS EVALUATION OF A HELIBORNE ELECTRONIC WARFARE SYSTEM (AN/ALQ-151, QUICK FIX)

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FOREWORD

As the equipment used by the armed forces becomes progressively more complex, it places a greater demand on the individual soldier. To avoid overloading the mental and physical capabilities of the soldier, it is important to analyze newly developed weapons systems to determine how the man-machine interfaces of such weapons can best be designed for optimal use by the operator. To this end the present human factors evaluation of a heliborne electronic warfare (EW) system was conducted in March 1977, at Fort Hood, Tex., in response to a human resources need sponsored by the Training and Doctrine Command (TRADOC) Combined Arms Test Activity (TCATA). This report supplements the TCATA Operational Test 174 Report and contributes to determining system modifications and determining whether to enter low-rate initial production of the EW system.

JOSEPH ZEIDNER
Technical Director (Designate)

B

HUMAN FACTORS EVALUATION OF A HELIBORNE ELECTRONIC WARFARE SYSTEM (AN/ALQ-151, QUICK FIX)

BRIEF

Requirement:

This research was conducted as a human factors evaluation of a Heliborne Electronic Warfare System (AN/ALQ-151, Quick Fix) in response to a request from the TRADOC Combined Arms Test Activity (TCATA). The evaluation was conducted in conjunction with TCATA OT 174 (Electronic Countermeasures (ECM) Quick Fix Operational Test II). This report, designed to supplement the TCATA OT 174 Test Report, identifies man-machine interface problems that pose possible hazards to system operators and reduce system effectiveness. The report also suggests changes in hardware design, operating procedures, and training procedures, to alleviate these problems.

Procedure:

Data were collected using three different methods: questionnaires and interviews, measurements of hardware, and experiments. Data were gathered with respect to individual hardware components, workspace and overall equipment configuration, environment, safety, operating procedures, and training. The data were analyzed to determine whether (a) the operators of the Quick Fix system were having problems with the system and (b) the hardware design met military specifications. Problems encountered were analyzed and discussed with the operators and pilots to determine how they could best be corrected.

Findings:

Modifications (as recommended) of selected man-machine interface components of the Quick Fix system will improve the effectiveness of the system.

The overall configuration of the equipment for the direction finding position and the countermeasures position, such as the location of the crew call and master caution signals, should be modified.

The overall configuration of the Quick Fix equipment for the pilot positions should be modified to improve both crew safety and systems effectiveness.

Two environmental problems requiring attention include aircraft ventilation and the degradation of night vision.

Several changes should be made in system operating procedures and future training programs, e.g., changes in procedures for effective communication between the pilot and the direction finding operator.

Utilization of Findings:

Findings of this research will be considered in conjunction with other test data to identify needed changes in equipment design, training programs, and operating procedures to maximize the effectiveness of the Quick Fix system. The results will also be used to determine whether to enter low-rate initial production of the system and to assist in the design of future electronics warfare systems.

HUMAN FACTORS EVALUATION OF A HELIBORNE ELECTRONIC WARFARE SYSTEM (AN/ALQ-151, QUICK FIX)

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INTRODUCTION

The AN/ALQ-151, Quick Fix system is a recently developed, special-purpose electronic warfare (EW) system that is configured in an UH-1H helicopter. The system has an electronic countermeasures capability that enables it to interfere with enemy radio transmissions and an electronic-surveillance capability that can be used to interrupt and determine the location of enemy emitters.

Any military system should be made as effective as possible because of the high stakes involved in an armed conflict. It is even more important, however, that an airborne EW system be as effective as possible because of the limited time it can be in operation because of its vulnerability and fuel limitations.

To insure maximum effectiveness in the Quick Fix system, the human factors evaluation presented in this report was conducted while Quick Fix was undergoing an Operational Test II by TCATA at Fort Hood, Tex. The purpose of the research was to identify any man-machine interface problems that might reduce the effectiveness of the system and to develop changes in hardware design, operating procedures, and training programs to optimize the effectiveness of the system. In addition to improving the Quick Fix system, the results of this report can be used to improve the design of similar systems in the future.

METHOD

Three sources provided data to meet the objectives of this report: questionnaires and interviews, hardware measurements, and experiments.

The pool of subjects available for this research was limited to four enlisted men who had been trained to operate the Quick Fix equipment and four helicopter pilots who had been assigned to fly the aircraft during developmental and operational testing.

Questionnaires and Interviews

All system operators and pilots were asked to complete questionnaires concerning any problems they had while interfacing with the Quick Fix equipment. The first questionnaire administered to the Quick Fix operators (Appendix A) focused on four different areas of the direction finding (DF) system: individual equipment components, workspace, environment, and safety. The questionnaire was administered while each operator sat in the

DF operator's seat so that he had direct reference to the equipment. The interviewer sat next to the operator in the countermeasures position and recorded the explanations the operators gave for "borderline," "inadequate," or "very inadequate" responses, as well as any other relevant comments the operator wished to make. Each interview lasted approximately 90 minutes.

One week later a similar questionnaire was administered to the operators (Appendix B). This questionnaire took about 45 minutes and focused on the countermeasures position,[1] general operating procedures, and training. At this time the Quick Fix pilots were also administered a questionnaire of similar format, focusing on aspects of the Quick Fix system that were of concern to them (Appendix C). Areas covered included individual equipment components, overall equipment configuration, safety, operating procedures, and training. These interviews lasted about 90 minutes.

The results of these questionnaire-interviews are summarized in the results section of this report. The analysis of these results served as input to the recommendations for changes in equipment design, operating procedures, and training procedures.

Hardware Measurements

Physical measurements were taken of the hardware to supplement the questionnaire-interview data and to determine whether military standards had been adhered to in the construction of the system. These measurements consisted of determinations of knob and dial size, as well as configuration and style. The measurements and observations were then compared with the standards listed in Military Standard 1472A and Military Handbook 759.[2] Design characteristics that failed to meet military standards are noted in this report.

Experiments with Gloves

Army Regulations require that operators wear Nomex flight gloves when flying missions in the Quick Fix aircraft. It was thought that wearing such gloves would interfere with manual dexterity and lower the performance of the operators. Any performance degradation caused by the use of gloves would also seem to be exacerbated by the vibration and movement of the aircraft while it was airborne.

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[1]The countermeasures set itself (TLQ-27) was not evaluated.

[2]Military Handbook 759. Human Factors Engineering Design for Army Material, 1975.

These hypotheses were tested in an experiment in which operators performed two different tasks under four different conditions. The four conditions involved two levels of the glove variable (not wearing gloves versus wearing Nomex flight gloves) combined with two levels of the flight variable (helicopter on the ground with blades rotating versus helicopter in the air).

For the airborne condition, pilots were requested to fly at 200 ft. and rate the amount of turbulence experienced during the flight using the following scale: 1 = no turbulence, 2 = light turbulence, 3 = medium turbulence, 4 = heavy turbulence, and 5 = extreme turbulence. In all conditions, all pilots rated the turbulence as light.

In one task, the operator entered a series of radio frequencies and related information (type of gain control, type of signal modulation, and bandwidth) into the system via the receiver control unit (RCU) panel. The individual who normally performed organizational maintenance on the system sat in the countermeasures position and, simulating the operations center on the ground, read the information over the intercom to the operator at a rate of 2 digits per second. After the task was completed, the organizational maintenance man recorded the time and number of errors made by the operator. Operators received a different list for each condition (Appendix D). The lists, however, were comparable in terms of the number of units of information each contained.

The second task consisted of an intelligence message (Appendix E) that the operator was required to enter into the system via the keyboard. The messages, one for each experimental condition, were placed next to the keyboard; and the time required to enter each message was recorded. Each typed message was later printed out by the teleprinter, and the number of errors per stroke were counted. (Although each message had between 373 and 376 spaces and letters, the teleprinter malfunctioned several times and failed to print out the full message as it had been typed in, thus requiring that the data be reduced to number of errors per stroke instead of number of errors per message.) Time-to-task completion and number of errors were recorded for each task and for each of the four test conditions.

RESULTS

The Quick Fix system is made up of three subsystems with respect to man-machine interfaces: (a) the DF system; (b) the active countermeasures system; and (c) the navigation system, which is used primarily by the helicopter pilot. Each of these systems will be discussed separately.

Direction Finding System

The Quick Fix direction finding system is located directly behind the pilot's position in a UH-1H helicopter. An operator uses the system by stepping or sweeping through various radio frequencies. When activity is detected on a given frequency, the system is tasked to establish a line of bearing from the helicopter to the radio that is emitting on that frequency. When two or more lines of bearing have been established with the helicopter in different locations, the system's computer can be tasked to "fix" the target emitter, i.e., locate it in 8-digit coordinates. It should be noted that the system is designed to interface with two or three helicopters in the air simultaneously so that an operator can immediately get lines of bearing from two or three different locations when he discovers activity on a given frequency. Only one Quick Fix system, however, was available for testing at TCATA, so this aspect of the system could not be evaluated. Instead, this evaluation was concerned with one Quick Fix system acting alone.

Components that the DF operator uses while operating the DF system (Figure 1) include (a) a receiver control panel (RCU) for entering radio frequency information into the system; (b) DF control indicator panels for tasking the system to take lines of bearing (LOB's) or fixes, and for accessing various parts of the computer memory; (c) a keyboard that enables the operator to enter gist information and messages into the system; (d) a plasma display that uses alphanumeric and vectographic information to portray LOB's and target fixes; (e) a panoramic indicator that is a cathode ray tube that graphically represents activity on the radio frequency being monitored, as well as representing activity occurring in a specified bandwidth on either side of the monitored frequency; (f) a VHF transceiver for air-ground communications; (g) a status control indicator panel, which alerts the operator to conditions needing attention; (h) an indicator panel containing a master caution panel, a C-1161 control set for the operator's communications system, and a communications processor for interfacing with other DF systems; (i) a distribution box of circuit breakers; (j) a teleprinter for printing out messages that have been entered into the computer; (k) a recorder/reproducer for recording transmissions over radio frequencies that are being monitored and for recording messages from the operator; and (l) an overhead C-1161 auxiliary communications control set.

Receiver Control Panel (RCU). The receiver control panel (Figure 2) is the part of the Quick Fix system that enables the operator to step through or sweep through a series of frequencies to search for traffic on them. Measurements of the control and display layout of this panel showed that it met the design specifications listed in Military Standard 1472A. Nevertheless, several features caused problems for the operators. For instance, two operators indicated that it was difficult to read the tuning frequency display when the sun was shining on it. This problem could be corrected by having a small glare shield mounted around the display.

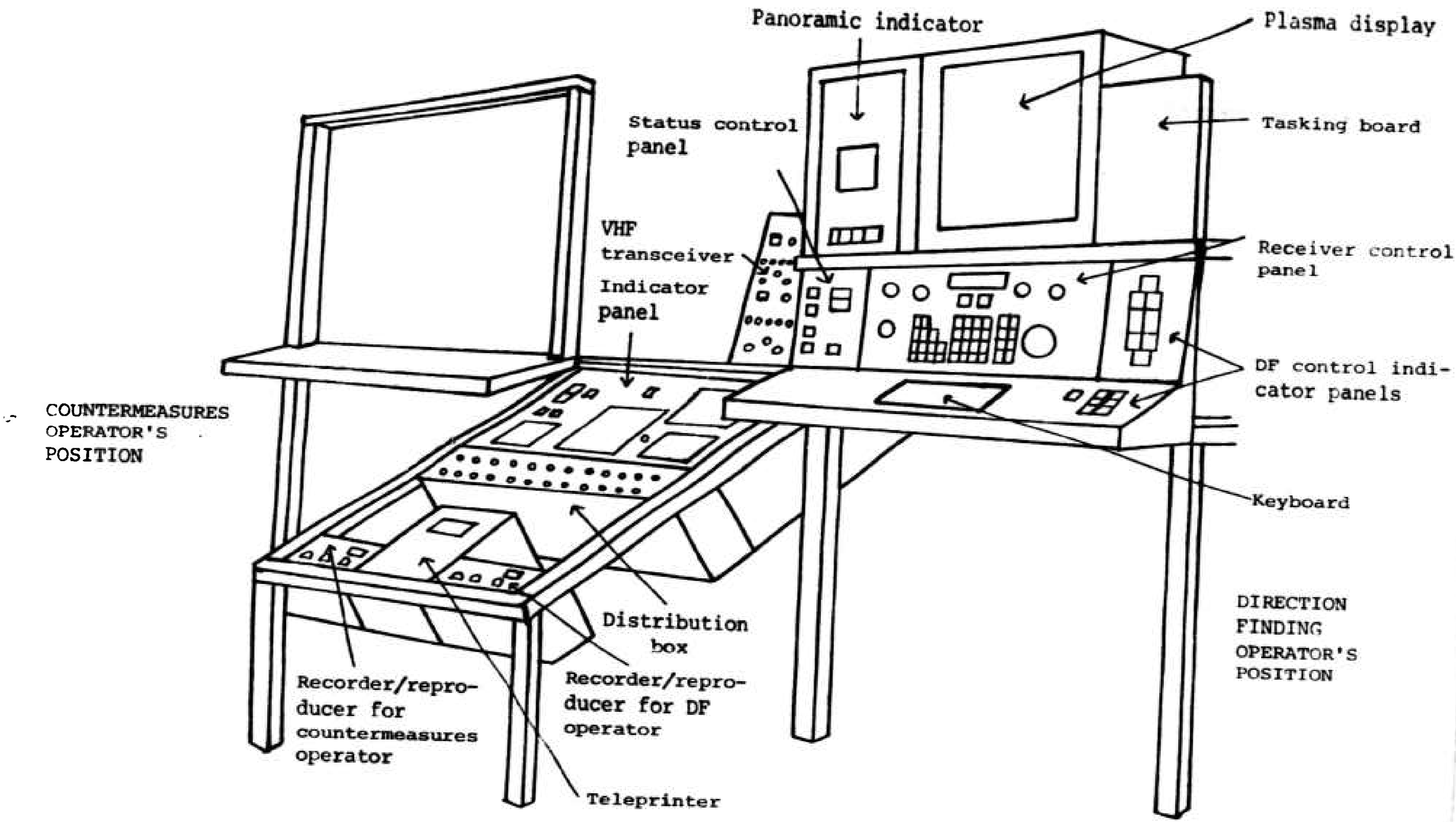


Figure 1. Overall equipment configuration of direction finding operator's position and countermeasures operator's position.

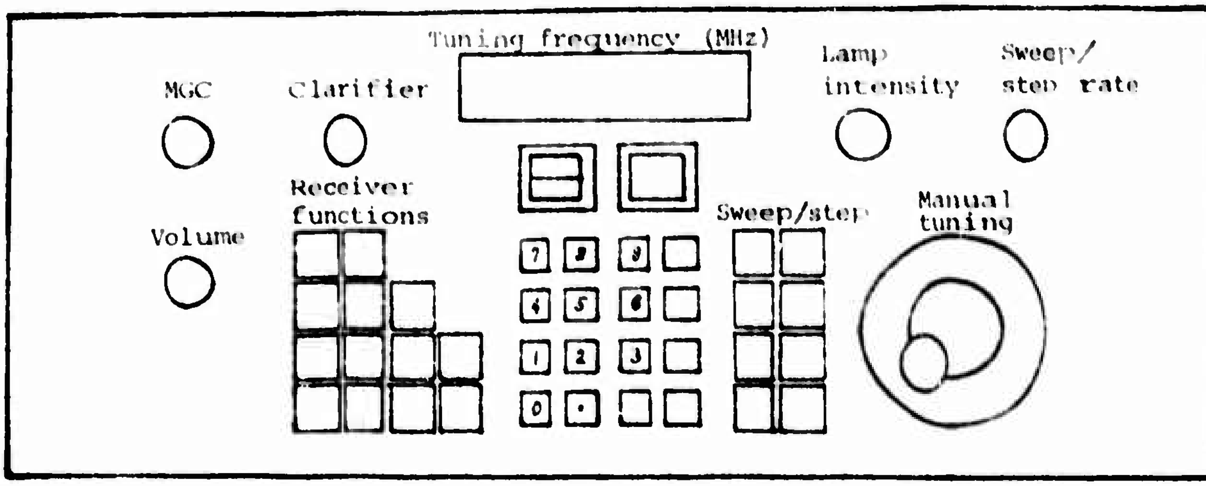


Figure 2. Receiver control panel (RCU).

Two operators indicated that when wearing the Nomex flight gloves they sometimes entered a wrong frequency because their fingers would slip off a given numeric key and hit another one, or they would accidentally hit two keys at once. This problem was further investigated by the experiment described earlier. As explained then, four operators were tasked to enter into the RCU a series of frequencies and related information under four different experimental conditions. The results, shown in Table 1, reveal that few errors were made under any of the experimental conditions, and there were little differences in the time required to enter a list into the RCU for the "gloves on" versus "gloves off" conditions. The small size of the sample precluded any meaningful statistical tests of the data. Thus, one cannot conclude from this experiment that wearing gloves and being airborne influences performance on this type of task. However, because the performance measures tended to show degraded performance when subjects were airborne and wearing gloves and because the sample was so small, this problem should be investigated in more detail.

Even though few errors were made, operators' comments indicated that the interkey distance on the RCU panel should be greater than the 1/2-inch minimum specified in Military Standard 1472A and Military Handbook 759 (the specified preferred interkey distance is 1 inch).

<u>DF Control Indicator Panels</u>. These panels (Figure 3) consist of a number of pushbutton keys that allow the operator either to call up various pages of computer memory or to task the system to perform certain operations, such as taking a line of bearing (LOB) or calculating a fix on a radio station.

Table 1

Time Required to Enter List of Frequencies and Related Information into RCU and Number of Errors Committed

Operator	Ground: Gloves off	Ground: Gloves on	Airborne: Gloves off	Airborne: Gloves on
List time (in seconds)				
1	84	89	92	90
2	127	110	123	137
3	136	141	123	123
4	135	135	180	190
Average	120.5	118.75	129.5	135
List errors				
1	0	0	0	0
2	0	0	0	0
3	1	0	0	0
4	0	0	0	1
Average	.25	0	0	.25

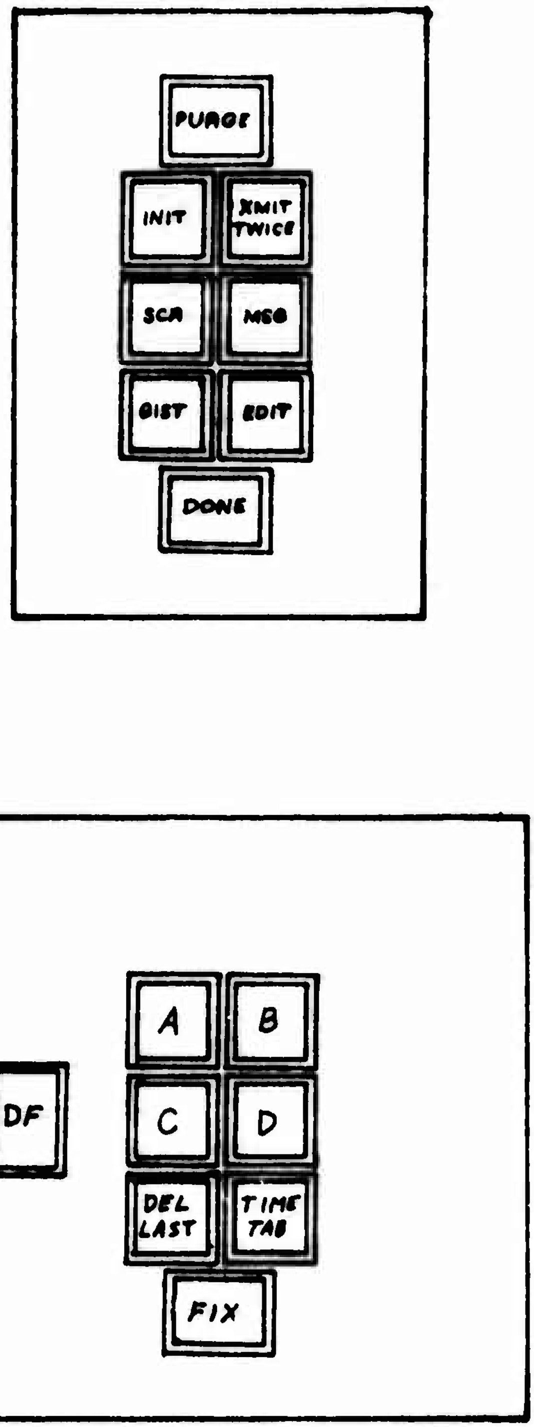


Figure 3. Direction finding (DF) control indicator panel.

Measurements of these panels revealed that the design did not conform to the specifications of Military Standard 1472A with respect to distance separating adjacent keys. Military Standard 1472A specifies a minimum interkey distance of 1/2 inch, whereas the present design has essentially no distance separating the keys in each panel with the exception of the DF key. Operators did not indicate that this caused any problem. All four operators, however, complained that there was a lack of feedback from the keys when they attempted to activate them. They complained that some keys had to be pressed two or three times before they were activated. This was a particular problem with the DF key because it sometimes takes the system as long as 5 or 6 seconds to determine a line of bearing after the DF key has been pushed. Operators said that sometimes they were not sure they had pressed the key hard enough to activate the DF command; this caused confusion as to whether the key should be pressed again. Such confusion and delay may involve only a few seconds, but it is possible that a threat radio could stop transmitting during that time, thus causing a failure in obtaining an LOB and perhaps ultimately a failure in fixing the threat location. To eliminate this problem, the operators suggested that a signal appear on the plasma display when the system is computing a line of bearing. Adoption of this suggestion appears to be a satisfactory way of solving the problem because the operator's attention is directed to the plasma display after he has hit the DF key, and he would therefore get immediate feedback as to whether the system was acting on the DF command. With other keys, the differential between the increasing resistance and the sudden drop in resistance that occurs when the key is activated should be increased to provide more feedback concerning whether keys have been pushed hard enough to activate their functions.

Keyboard. The keyboard is basically a standard IBM typewriter keyboard with some changes in the symbols on various keys. The keyboard is used by the operator to enter system functions into the computer and messages for later retrieval and to respond to system questions. Operators had two basic comments about the keyboard.

First, they indicated that when airborne and wearing flight gloves, it is easy to make typing errors. The errors indicated were hitting two keys at once, hitting the wrong key, and hitting a single key several times in succession instead of just once. These responses lead to the question, What is the magnitude of the degradation resulting from wearing flight gloves and being airborne? An attempt was made to answer this question by performing the "glove experiment" described earlier, but the results were nonconclusive (see Table 2). It should again be noted, however, that a larger sample size might have demonstrated statistically significant differences. Further investigation is warranted.

If there is degradation in typing as a result of wearing the gloves and being airborne as operators claimed, then it would be worthwhile to consider designing keyboards in similar systems with the capacity to adjust the resistance of the keys so that each operator could set key resistance to optimize effectiveness.

Table 2

Time Required to Enter Message into Keyboard and Number of Errors Committed

Operator	Ground Gloves off	Ground Gloves on	Airborne Gloves off	Airborne Gloves on
	Message time (in seconds)			
1	143	140	122	143
2	197	125	220	210
3	239	258	225	235
4	118	212	170	197
Average	174.25	183.75	184.25	196.25
	Errors per stroke			
1	.003	.019	.008	.013
2	.093	.076	.051	.051
3	.038	.011	.005	.030
4	.008	.000	.022	.140
Average	.036	.027	.022	.059

A second comment made by two operators was that it was difficult to see the symbols on the keys at night. This problem could be alleviated by having self-illuminated keys or a small lamp located just above the keyboard at the intersection of the keyboard panel and the RCU panel.

Plasma Display. The plasma display is a panel on which lines of bearing and location fixes are displayed graphically. In addition, any commands or other information typed into the system appear on the display, as well as any questions or instructions the computer gives to the operator. The major criticism of the display was that it is difficult to read

when the sun is shining on it. This problem may be eliminated by attaching a 12-inch retractable glare shield onto the side of the display. Another solution would be to attach a blackout shade on the window next to the DF operator. This shade would also allow him to be blacked out at night and, thus, enable him to turn up the lights in his area if he needed to.

Another comment concerning the display was that it is difficult to clean off smudges and fingerprints and this, too, causes a problem when light reflects off the display surface. Consequently, cleaning solvent should be supplied to operators so they can clean the display surface in flight.

Three operators said that bearing headings should be permanently etched into the periphery of the plasma panel (Figure 4) so that the operator could rapidly indicate to the pilot the direction of a target radio.

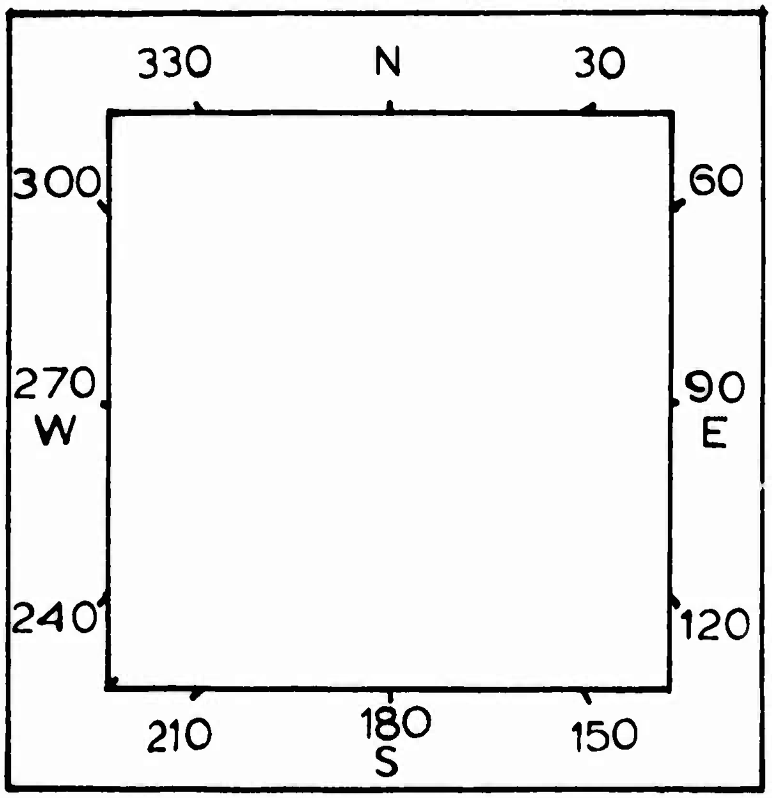


Figure 4. Recommended design of plasma panel.

Finally, one operator commented that it would be helpful if there were a way of entering call signs onto the LOB/EDIT page so that when an LOB/EDIT page is called up for a given frequency, the call signs for the LOB's that are displayed are also displayed.

Panoramic Indicator. The panoramic indicator is basically a cathode ray tube that graphically presents the signal being monitored by the Quick Fix system, as well as the signals occurring on frequencies on either side of the frequency under scrutiny. The bandwidth of frequencies portrayed can be set at either 2 megahertz or .2 megahertz.

Three operators said that they seldom tried to use the panoramic indicator because it is too difficult, if not impossible, to determine in a reasonable amount of time which frequency is responsible for the activity on the indicator. One operator said that when he did use the indicator, it was only with the .2 megahertz bandwidth. This, of course, substantially reduces its usefulness. Continued inclusion of the panoramic indicator in the Quick Fix system should be reconsidered, or it should be refined so that it is more useful to operators. It is possible that, with more training, operators could learn to use the panoramic indicator. This problem needs to be investigated further.

Finally, it should be noted that the bolts used to hold the panoramic indicator in position pose a safety hazard. The bolts protrude approximately 3 inches and could cause severe injury if an operator were thrown against them during severe turbulence or in a crash. Another way to hold the panoramic indicator in place should be devised.

VHF Transceiver. The VHF transceiver allows the operator to communicate over VHF channels. Operators had no adverse comments about this equipment.

Status Control Indicator Panel. The status control indicator panel (Figure 5) consists of four pushbutton keys/signals and a master caution signal. Operators' comments were directed to the crew call signal and master caution signal. The crew call signal flashes 20 times with an orange light when activated, indicating that all operators and pilots should switch their C-1611 control set to the intercom mode. The master caution signal lights up in bright orange, indicating that a light on the master caution panel is on. The problem with both the crew call and master caution signals is that operators did not notice them while they were watching the plasma display and the DF control indicator panels on the other side of the apparatus. The problem with the crew call signal is serious because it is the only safe way pilots can indicate to the operator that they want to communicate. All pilots complained of this problem. The problem with the master caution light is also serious because prolonged inattention to a caution condition could easily lead to serious equipment malfunction. The problem with both signals could be remedied by providing an audio signal with visual signals and by relocating the signals to a more central location with respect to the

operator's activities. Ideally, this would be on either side of the tuning frequency display or in the plasma display itself. Another possible, although less desirable, alternative would be to relocate the signals between the keyboard and the DF switch.

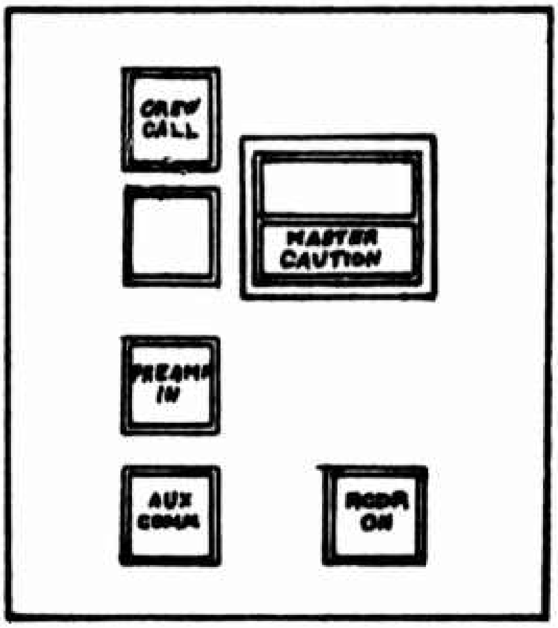


Figure 5. Status control indicator panel.

Indicator Panel. The indicator panel (Figure 6) consists of (a) a master caution panel that indicates power supply failures, overly high operating temperatures, and other equipment problems of concern to the operator; (b) a mission zeroize switch for erasing computer memory; and (c) a master caution signal and crew call signal for the countermeasures operator, which will be discussed later in the countermeasures section of this report. Located below the DF operator's caution panel is a C-1611 control set for interfacing with the communications systems in the aircraft. A C-1611 is located below the countermeasures operator's master caution signal. Finally, there is a communications processor control indicator located just below the mission zeroize switch. This processor enables the pilot to interface his Quick Fix system with other DF systems in the air or on the ground.

Because the Quick Fix system was tested in the single mode, operators were not able to evaluate the communications processor control indicator. With respect to the other items, there was only one comment: The visibility at night of the toggle switches on the C-1611 was poor. The length of these toggle switches was only about 1/4 inch, which is

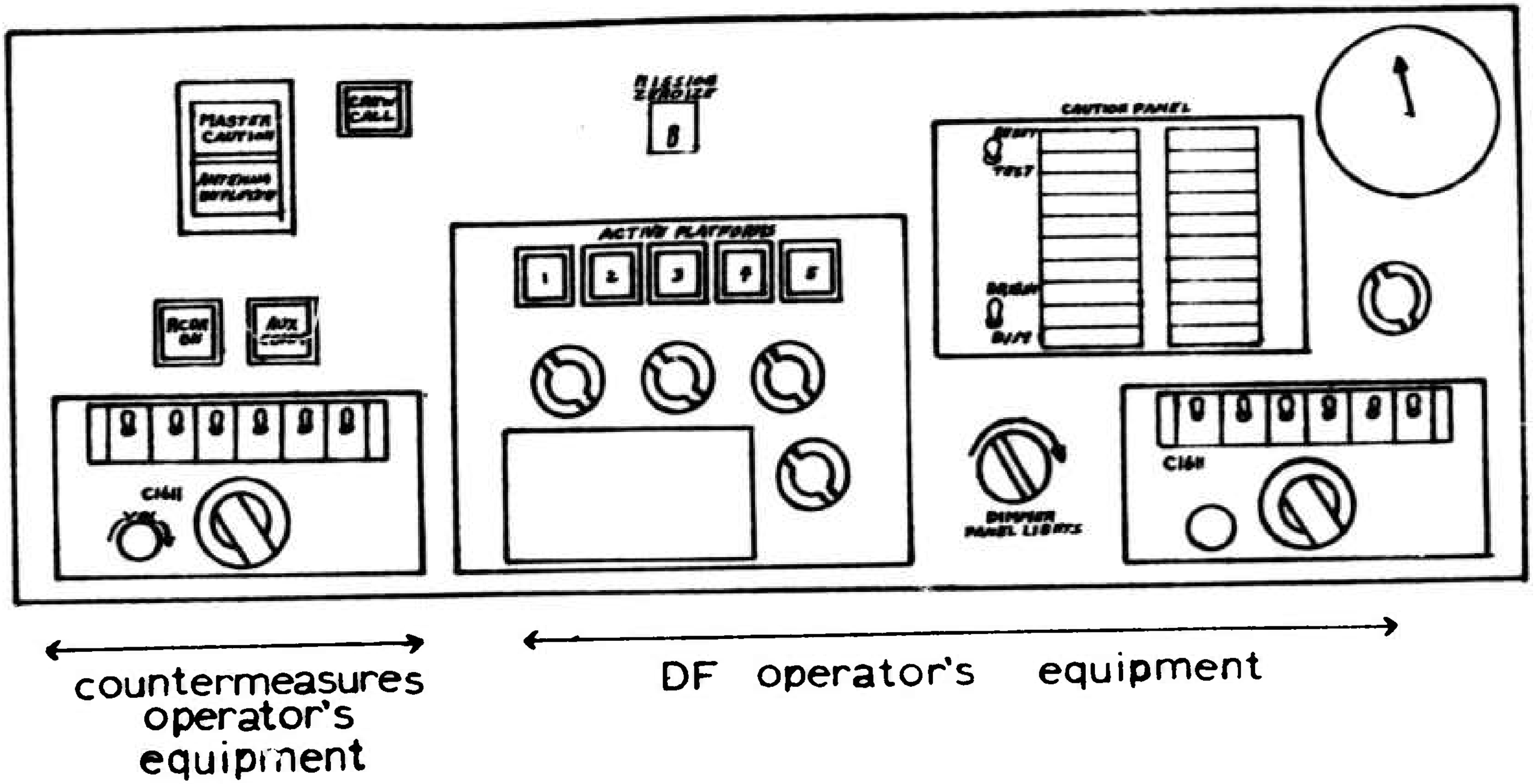


Figure 6. Indicator panel.

much shorter than the minimum prescribed by Military Standard 1472A (1/2-inch for the bare hand and 1-1/2 inches for the gloved hand). None of the operators indicated, however, that they had difficulty operating these switches; it would seem that the equipment may be acceptable as it is.

Distribution Box. The distribution box consists of a series of circuit breakers for equipment of concern to operators. Only two comments were made. One operator said that at night it was difficult to see if a circuit breaker had tripped, and low-level illumination would be helpful. Two other operators indicated that they could not identify all of the labels, but would like to so that they could tell which piece of equipment was having problems when a circuit breaker was tripped. This latter problem could be eliminated by including an explanation of the circuit breaker labels in the operator's manual.

Teleprinter. The teleprinter (Figure 7) is used to print out a paper copy of messages and intelligence information that have been stored in the computer. Operators had several comments about the teleprinter. One comment concerned the size of the controls and the spacing between them. Two operators said that it is difficult to operate the controls with gloves on because the controls are too small and there is not enough space between them. It should be noted that although the toggle switches on the teleprinter just meet ungloved hand specifications (1/2 inch in length), they fall short of the gloved-hand specifications (1-1/2 inches in length) given in Military Standard 1472A. Consideration should be given, therefore, to increasing the length of the toggle switches and increasing the space between the controls so they can be easily manipulated with the gloved hand.

Another comment about the teleprinter was that a paper take-up would be helpful for rolling up the paper tape as it is printed out by the teleprinter. Currently, the paper printed out blows around if the doors are open. A paper take-up or rack would eliminate this problem.

Finally, two operators complained that it is difficult to see the teleprinter controls and what is being printed because of the controls' location, especially if the operator is busy. This problem will be discussed later in this report.

Recorder/Reproducer. The recorder/reproducer (Figure 8) is used to record, on a tape cassette, voice transmissions that are occurring over a monitored frequency, as well as any messages the operator himself wishes to record.

The major complaints about this piece of equipment were similar to those of the teleprinter; namely, the controls are too small to use easily with the gloved hand and too difficult to see the controls, especially if the operator is busy intercepting and performing other DF functions.

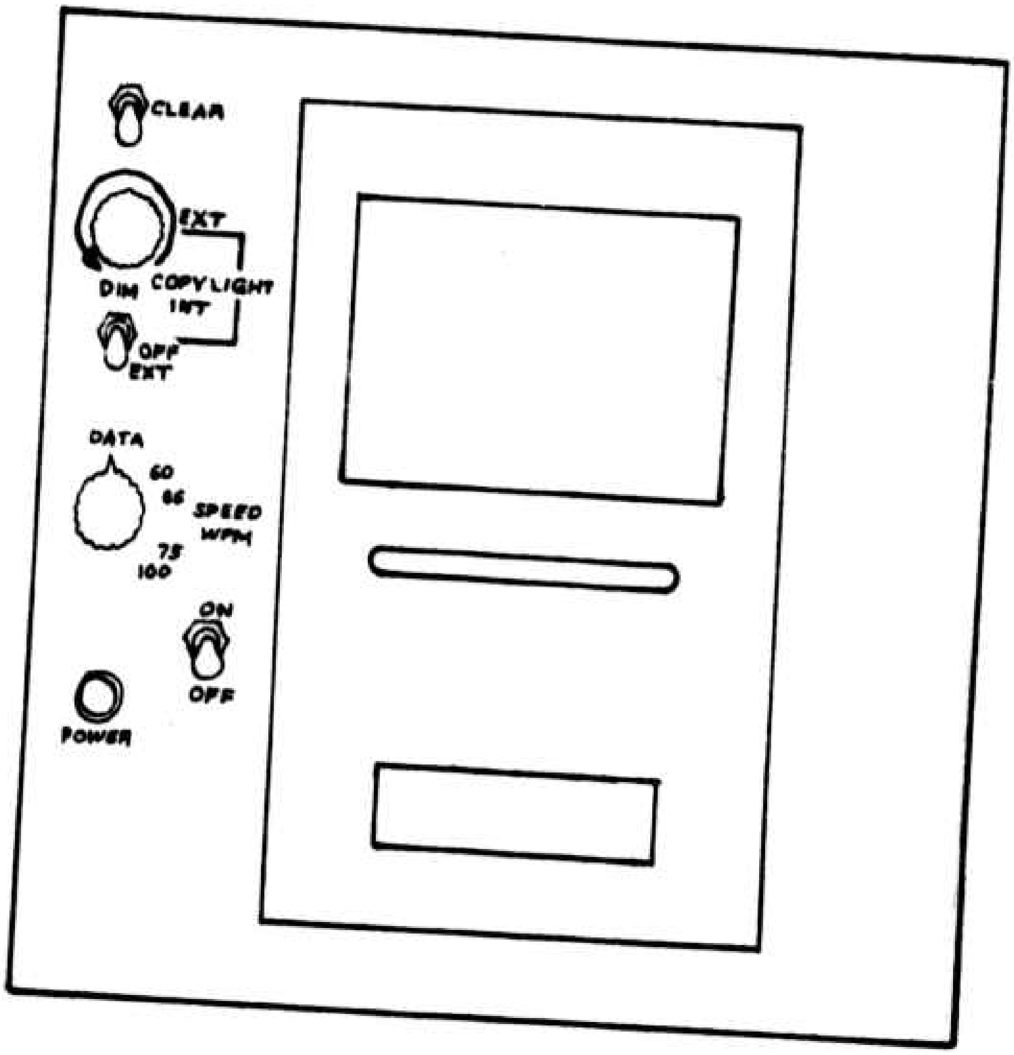


Figure 7. Teleprinter controls and indicator.

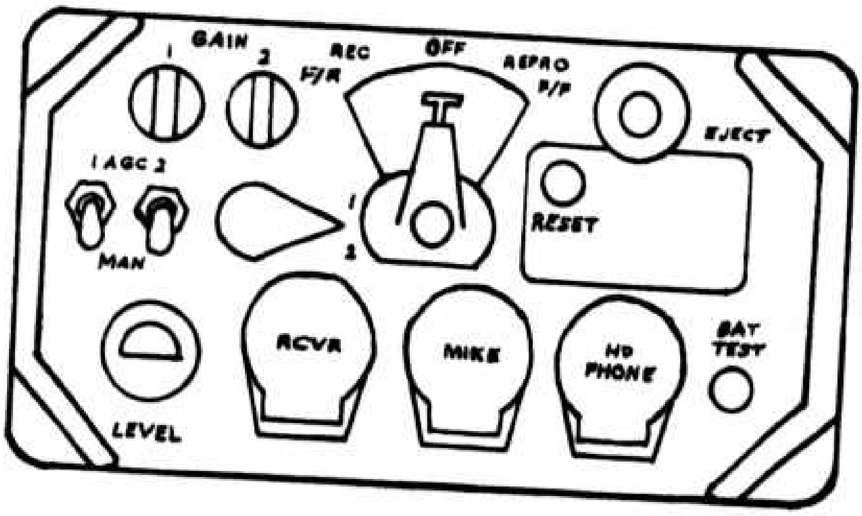


Figure 8. Recorder/reproducer.

Measurements of this equipment showed that the toggle switches do not conform to gloved-hand specifications, and the distance between the toggle switches and gain control knobs (.25 inch) are short of Military Standard 1472A minimum specifications (1 inch). In addition, the sides of the recorder extend beyond the face panel on which control knobs and toggle switches are attached, further restricting the free space around the controls. This condition is also characteristic of the teleprinter.

Future systems using this equipment should correct the problems listed above before adopting the equipment as part of the total system.

Another criticism of the recorder, made by two operators, was that it is difficult to extract the tape cassette, a problem if the operator were airborne and needed to change tapes quickly. It should be noted, however, that normally one tape cassette will be sufficient to last the entire mission, so this should not be a problem. If the recorder were started early in the mission, however, and then the operator forgot about it (as one said he had done), then it would be possible to run out of tape during a mission. This leads to another problem, namely, that there is no indication when the tape has run out. A signal to indicate this perhaps should be built into the recorder.

Finally, two operators said that they did not understand all of the labels on the recorder.

In summary, a pushbutton recorder would probably be more satisfactory than the recorder now in the system.

<u>Workspace and Overall Equipment Configuration</u>. Operators were queried about their satisfaction with the workspace for performing duties and whether they were satisfied with the way the equipment components were configured as a system. They had no comments about the workspace, although three noted that it would be useful to have a rack for storing tasking sheets, clipboards, and other similar items so they would not bounce around when the helicopter was airborne and the doors were open. Such a rack could be conveniently placed on the side of the assembly rack where the trash rack, which is seldom used, is currently located.

With respect to the overall configuration of the equipment, there were three basic comments. First, and most important, three operators said that the teleprinter and recorder need to be in a more visible location. The suggestions they gave for relocation were to place the teleprinter and recorder adjacent to the plasma display where the tasking board is currently located, or to place the recorder where the tasking board is and the teleprinter where the recorder is, angling it toward the operator.

The second comment was that the operator's chair is not centered on the keyboard, making it difficult to type; operators, however, say they can adjust to this situation. Measurements of the system showed that the operator's chair is centered on the "shift" key of the keyboard; moving

the keyboard over 4 inches or moving the chair 4 inches would solve the problem. Either solution would be satisfactory.

Two operators said that the overhead C-1611 auxiliary communications system control set is in an awkward position. The set is located overhead, above the operator's left shoulder, and faces the countermeasures side of the aircraft, thus causing the operator to lean to the left and twist his neck upward and to the right to see it. Normally, the controls on this radio are adjusted while on the ground, but it is awkward to change them while in flight. This problem may be alleviated by rotating the control set 90° so that it faces the operator.

Several safety issues were noted by operators as well as by pilots. First and most important is the lack of a readily accessible fire extinguisher or first aid kit. The one fire extinguisher in the helicopter is located on the floor between the pilot and the door. Operators say they cannot reach this fire extinguisher; if a fire were to break out in the DF or countermeasures area, it could result in serious injury to the operators and damage to the equipment before the pilot could get the fire extinguisher and hand it back to the operators. Operators stated that a second extinguisher should be mounted on the wall or rack assembly directly behind the DF control box where it would be accessible to both the DF operator and the countermeasures operator. This location would also be good for a first aid kit. There are four first aid kits in the helicopter, but none can be reached by the operators. Airsickness bags should be located with the first aid kits. Lack of these bags has the potential for lowering performance for both operators, even if only one should become sick.

Finally, three operators noted that the cables from the DF and countermeasures equipment were not well secured and, consequently, hung down underneath the equipment, sometimes becoming tangled with operators' legs. Also, one pilot stated that the cables in the aft rack assembly where the computer and related equipment are stored are very long and loose and rub against the door and floor, thus causing wear on the insulation and resulting in an electrical hazard. These equipment cables should be well secured throughout the aircraft to prevent accidental entanglement and worn insulation (and possible shorts or shocks).

Countermeasures System

The operator in the active countermeasures position (Figure 1), configured behind the copilot's position, operates the AN/TLQ-27. This piece of hardware and the encryption devices on the aircraft are classified equipment and were not evaluated in this study. The operators were, however, asked to evaluate nonclassified aspects of the equipment, such as the equipment on the indicator panel (Figures 1 and 6) for use by the countermeasures operator. This equipment includes a C-1611 communications control set, several pushbutton switches, a crew call signal, and

a master caution signal. An overhead C-1611 auxiliary communications control set is also included for aircraft communications.

The first comment made by operators was the same as one mentioned earlier; namely, the overhead C-1611 is difficult to see because of its orientation. The difficulty could be reduced by simply rotating the set 90° so that it is facing the operator.

The second comment is of more importance and concerns the fact that the master caution signal and the crew call signal for the countermeasures position are not in the operator's field of view when operating the countermeasures set and, thus, he does not see either signal when activated. This problem may be eliminated by mounting the master caution and crew call signals on the countermeasures operator's worktable.

Three other comments were made about the countermeasures position. First, all operators said that a storage rack for papers, notebooks, and other items would be helpful. The rack could be mounted, as suggested for the DF operator's position, between the countermeasures rack assembly and the side of the helicopter. Second, two operators complained that the AN/TLQ-27 was mounted too far away for them to reach it comfortably; this was a problem because the operator has to keep his hands on the equipment for extended periods of time. The two operators having the shortest arms made this comment. The problem could be solved by lengthening the guides on which the operator's chair sits so that the operator could move the chair closer to the equipment.

Finally, three operators reported bumping and scraping their knees on the ashtray located under the countermeasures table. This usually happened when entering or exiting the aircraft. The ashtray should be relocated from the left side to the right side of the countermeasures table to avoid injuries.

Navigation System and Countermeasures Antenna Control

Pilots were asked to evaluate the navigational equipment of the Quick Fix system, as well as the countermeasures antenna control systems. Their comments follow.

Mission Power Control Panel. The mission power control panel, located in the overhead console, consists of three toggle switches and is used to control the supply of electrical power to the DF and countermeasures systems. Two pilots stated that the control panel is adjacent to the cabin heating panel, which also has a toggle switch, and that it is easy to flip one of the mission power switches inadvertently instead of the heater switch. During a mission, this could seriously interrupt the performance of the system. Pilots suggested that this problem could be corrected by using mission power switches that are shaped differently from the cabin heater switches to avoid confusion.

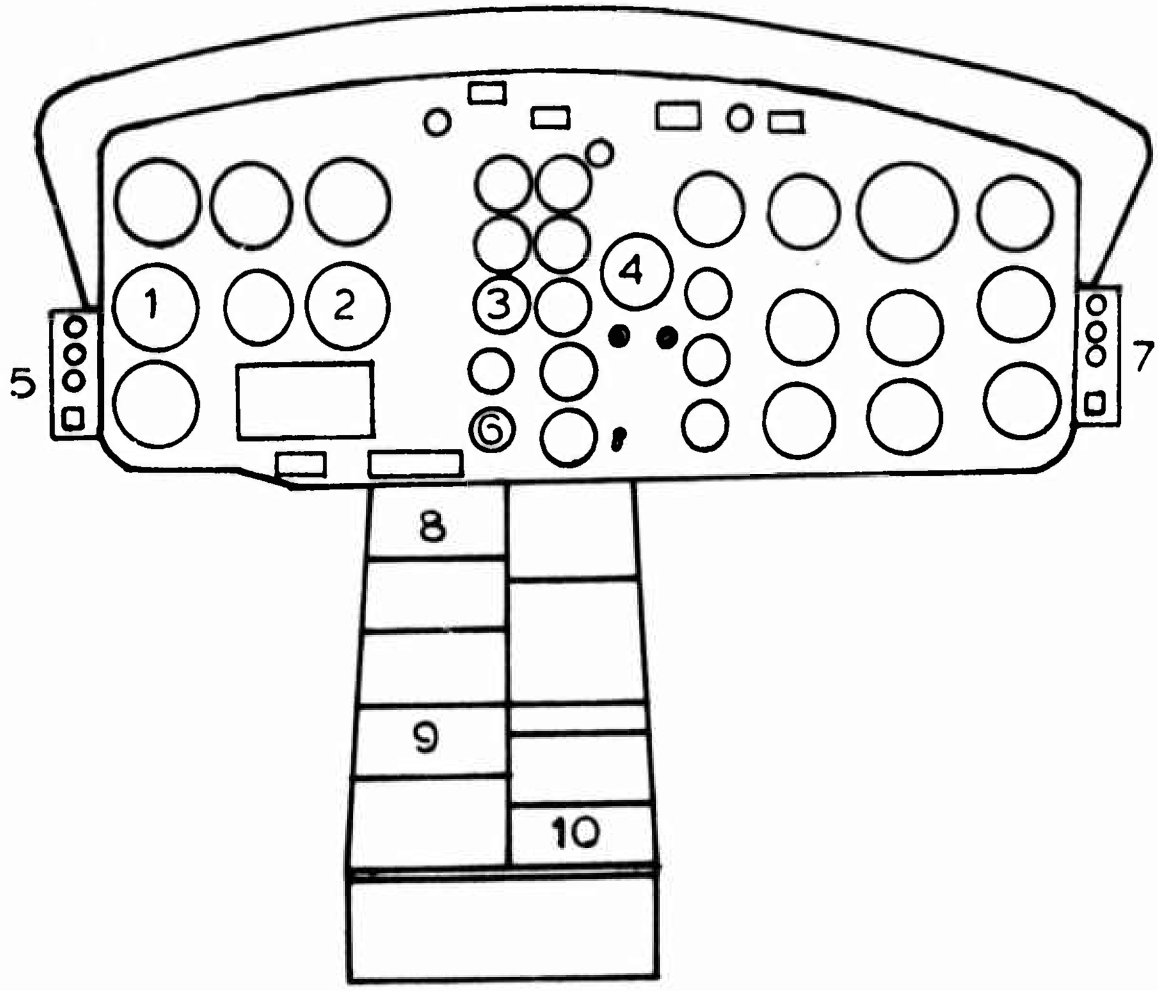
Countermeasures Antenna Control. The countermeasures antenna control consists of a control panel that is located next to the pilot on the lower end of the pedestal and two identical control displays located at opposite ends of the instrument panel (Figure 9). Pilots criticized the control panel as being in a position the pilot and copilot also used as a place to store logbooks and other items, which could perhaps prevent the circuit breaker in the panel from popping out at the appropriate time. Sometimes these items also bump the antenna control switch and cause the antenna to retract or extend at the wrong time. Although there is a metal guard on the switch, one pilot said that it frequently came off. Pilots also stated that the control panel should be located with the control display. Relocating the panel was recommended as the best solution to both of these problems.

The antenna control displays (one for pilot, one for copilot) consist of three colored lights indicating the position of the countermeasures antenna: retracted, green; in the process of being extended, orange; or fully extended, red. The displays also contain a crew call signal that flashes 20 times to indicate that either the DF operator or countermeasures operator wishes to talk to the pilots. The major comments made about this display were that (a) there is no way to adjust the brightness or flashing of the crew call signal, a serious problem at night because its brightness relative to the other lights interferes with the pilot's night vision; and (b) the antenna control and display should be located together.

With respect to the crew call signal, it should be designed so that the pilot can stop it from flashing once he has noticed it. The proposed co-location of the control panel and displays will be discussed in the section on overall equipment configuration.

Inertial Navigation System Control Panel. The inertial navigation system (INS) panel is used by the pilots to interface with the navigational system that the computer uses to keep track of the aircraft's location. The panel is next to the copilot, about halfway down the pedestal. Three of the four pilots voiced one major criticism about the INS panel. The pilots said it was impossible to read the settings of the 10-position thumbwheel switch at night when the lamp inside the switch burned out. Using a flashlight did not help because the glass window covering the wheel was curved and reflected the light to an extreme degree. The pilots complained that they were unable to replace the lamp in the panel. This panel must be redesigned so that either a flashlight can be used to read the switch or the pilots can easily replace a burned-out bulb in flight.

One pilot mentioned that the malfunction light on the INS is so small that the DF operator does not always notice on his plasma display when the INS system becomes inoperative. The system should be designed so that the malfunction light flashes on the INS panel.



Key:

1. Bearing distance heading indicator
2. Vertical velocity indicator
3. Transmission oil pressure indicator
4. Radar Hostile Air Warning System indicator
5. Copilot's countermeasures antenna control display
6. Standby generator loadmeter
7. Pilot's countermeasures antenna control display
8. Transponder
9. Inertial navigation system control panel
10. Countermeasures antenna control panel

Figure 9. Pilot's and copilot's instrument panel and pedestal.

Finally, all four pilots independently stated that the location of the INS panel constituted a safety hazard and must be changed for two reasons: (a) whenever pilots had to look down at it for relatively long periods of time, as in the case of updating the system, they experienced vertigo; and (b) the illumination of the panel reflected off the helicopter windows at night and decreased the pilot's night vision. One pilot recommended changing the bright yellow lights to red ones. These INS panel problems will be discussed further in the overall equipment configuration section.

Bearing-Distance-Heading Indicator (BDHI). This indicator receives input from the Quick Fix mission equipment and indicates the bearing, distance, and heading of a selected target radio. The BDHI is located next to the copilot's countermeasures antenna control display (Figure 9).

The primary comment the pilots made about the BDHI was that they seldom used it because it was not completely functioning and was too difficult to read from the pilot's position. Pilots suggested that the BDHI be moved to a more central position so that both the pilot and copilot could see it, and that it be made completely functional.

Pilots also said that the BDHI is not functional until the DF operator activates it. Until then, the BDHI gives the pilot no useful information. Pilots suggested that the BDHI be designed so chat when an operator takes an LOB on a target, the BDHI automatically will be activated to provide information on that target. What the pilots seemed to be stating here and alluding to throughout the interviews is that there was not enough communication between the DF operator and the pilots, and that the DF operator must keep the pilots informed as to what targets he is trying to locate so that the flight path can be adjusted to optimize the pattern of LOB's that can be obtained on a given target or set of targets. This problem will be discussed further in the training section.

Overall Equipment Configuration. Pilots were relatively dissatisfied with the overall configuration and location of their Quick Fix equipment. They felt that the BDHI needs to be located in a central position so that both pilot and copilot can see it. The equipment could be located just below the Radar Hostile Air Warning System indicator or placed between the copilot's vertical velocity indicator and the transmission oil pressure indicator (Figure 9). Either location would enable both pilots to view the BDHI.

Pilots also felt that the countermeasures antenna control panel and display should be located together and that one central location would suffice for both pilots. A possible location is next to the standby generator load meter.

Finally, pilots recommended that the INS panel should be relocated if pilots will need to attend to it as much as they did in the Development and Operational tests. It now poses a safety hazard by inducing vertigo and decreasing night vision. A suggestion was to switch the

locations of the transponder control and the INS control because the copilot spends much less time with the transponder than with the INS control panel. If this were done, however, the upper side of the INS display face plates should be elevated so that pilots could easily view them and so that the illumination lights would not reflect off the helicopter windows at night.

Environment

The operators had two basic comments about environmental conditions. First, all four operators complained that the ventilation system is not adequate to produce a comfortable working environment on hot days. If the doors are open or screens are in the windows, then heat is not a major problem. But it is not always possible to have screens installed before flying, and sometimes at take-off it may seem best to keep the doors closed.

How seriously such temperature extremes affect performance with this system is not known and is a question that perhaps should be investigated. There is extensive empirical evidence to show, however, that prolonged exposure (over 60 minutes) to high temperatures (over 90°F) lowers human mental performance in general.[3] Based upon the operators' complaints, it would seem worthwhile to consider a more effective ventilation system for the aircraft. Another solution that would help at least to keep the sun off of the operators would be to provide blackout curtains that the operator could simply pull across the window. This solution was mentioned earlier for the glare problem.

The second complaint about environmental conditions concerned illumination at night. It is necessary to use the overhead map lamps to illuminate the keyboard and other controls at night, but according to pilots this seriously interferes with night vision. As a result, it is necessary to provide a way of visually isolating the operators' work area from the pilots' area. During the test this was accomplished by hanging a piece of canvas between the DF operator's rack and the countermeasures operator's rack. Installation of a black curtain on a rod in this location would be more effective and would eliminate the need for the operators and pilots of each Quick Fix aircraft to find their own solution to this problem. It also reduces the need for the system to be redesigned to provide extra illumination on the keyboard and other pieces of equipment that are difficult to see at night.

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[3] Wing, J. F. A Review of the Effects of High Ambient Temperature on Mental Performance. U.S. Air Force, Aero-Medical Research Laboratory, TR 65-102. September 1965.

Operating Procedures

Operators commented on operating procedures and related activities. DF operators said they prefer to write down such information as call signs, times, frequencies, and other essential elements, rather than type the information into the gist page or scratch page. This is particularly true when operators are busy. Writing on the table, however, is somewhat difficult when airborne and encountering turbulence. Consequently, all of the operators borrowed pilot's clipboards to strap to their legs to provide a more stable writing surface than was provided by the table. It was recommended that such clipboards be issued to all Quick Fix operators in the future.

Another problem mentioned by pilots was difficulty in remembering which bin in the computer a given voice on a given frequency had been assigned to earlier. A given transmitter on a given frequency is normally assigned to one of five bins. However, if the operator hears a voice on a given frequency on which he has taken an LOB earlier but does not know what the call sign of the transmitter is, then he must remember to which bin that LOB was assigned. Developing a technique for identifying voices might be an area for future investigation.

Another problem mentioned by operators concerned the lack of independent volume controls on the C-1611 for talking to pilots on intercom and for intercepting. If the operator turns the volume control up in order to hear an attenuated voice transmission on one frequency and then suddenly switches to his intercom to receive a message from the pilot but forgets to turn down the volume control, the operator experiences extreme discomfort from the loudness of the pilot's voice. This problem can be corrected by having separate volume controls for the intercom and interception systems.

A problem related to the above was voiced by pilots as well as operators; namely, there is a serious need for DF operators to learn to communicate to pilots what they are doing and from which direction the signal they want to DF is coming. This is important because the BDHI is essentially ignored by pilots, and they set their flight path based upon the information from the DF operator. This problem, of course, is related to the need for placing bearing headings on the plasma panel and indicates the need for standing operating procedure (SOP) for pilot-DF operator communications to facilitate their interaction when flying a mission.

Another related problem concerned the lack of information the pilots had regarding the operation of the DF system. All of the pilots commented that they needed to know more about how the DF system operates so they could help troubleshoot if the system malfunctions and know what type of flight path to follow under various conditions. In this regard, it was pointed out that there is no DF operator's checklist for troubleshooting the system, and the creation of such a list would be extremely helpful. It was also noted that operators needed to be supplied with fuses so that a simple fuse blowout would no longer cause aborted missions.

Finally, all pilots expressed concern over the additional weight added to the aircraft by installation of the system. It was suggested that any pilot who had not flown the Quick Fix system be given several hours of orientation and practice time before flying a mission.

Training

Formal Training and Experience. The four Quick Fix system operators were initially trained on the system in a 2-week training course at the contractor's [Electromagnetic System Laboratory (ESL)] home office. The course consisted of 5 days of classroom instruction (46 hours) followed by 5 days of training on the system while it was airborne.

Three of the pilots who flew the Quick Fix aircraft in TCATA's operational test flew the aircraft for this training but received no classroom training on the Quick Fix system itself.

Following this formal training period at ESL, operators and pilots traveled to Fort Huachuca for Developmental Test II where they spent approximately 4 months participating in the test. Following this training period, operators and pilots traveled to Fort Hood and participated in Operational Test II, which lasted 5 weeks. At the end of this test, operators estimated that they each had approximately 150 to 200 hours of operational time on the Quick Fix system (half of this in the DF position and half in the countermeasures position). Two pilots who had been with the system since the original training at ESL had each spent 130 hours flying the aircraft (half the time as pilot and half as copilot), and the other pilot had a total of 154 flight hours with the system. The fourth pilot, who was stationed at Fort Hood, spent a total of 30 hours flying the aircraft. Pilots had extensive previous experience flying airborne DF systems (including the INS).

Manuals. Operators were asked to evaluate the manuals that they used in training. These manuals were (a) the AN/ALQ-151 Computer Reference Manual (Preliminary); (b) the AN/ALQ-151 System Operation Manual; and (c) a looseleaf notebook consisting of system photographs and diagrams, a description of the controls and indicators of the RCU, and a description of Stanfield's method for estimating the location of an emitter. Operators rated all of these manuals as adequate in terms of their usefulness. Operators were not provided copies of the Operator's Manual (TM 32-5811-010-10-1) and, therefore, did not evaluate it.

Pilots did not see any of the manuals until OT II at Fort Hood. At that time they skimmed through the AN/ALQ-151 System Operation Manual and the supplement to the Operator's Manual, Army Model UH-ID/H Helicopter (TM 55-1520-210-10). The major comment made about the System Operation Manual was that the spiral flight pattern shown in Figure 2-10 was no longer applicable and might even be misleading because future conflicts will most likely involve a relatively linear forward edge of battle area. The pilots rated the manuals as adequate to borderline. It should be

noted, however, that they stated they were not given the opportunity to thoroughly study the manuals. Pilot evaluations, therefore, should be considered with that fact in mind.

Future Training Programs. Operators and pilots were asked to name any operations or features of the Quick Fix system that should receive special emphasis in future training programs.

Operators suggested that pilots and operators need to learn to interact more and work as a team; this was mentioned by both operators and pilots several times during the interviews.

Pilots mentioned that they felt it would be beneficial to know how the DF system works so they could better plan their flight paths and could help troubleshoot the system when it malfunctions. Two pilots also said that they would like more instruction on the INS and how it interfaces with the DF system.

CONCLUSIONS AND RECOMMENDATIONS

The results of this investigation indicate that modification of most of the man-machine interface components of the Quick Fix system would improve the effectiveness of the system. Specific recommendations follow.

Direction Finding System

Receiver Control Unit Panel. A glare shield should be mounted around the tuning frequency display to reduce reflected sunlight.

The distance between the numeric pushbuttons should be increased to 1 inch to reduce inadvertent hitting of the wrong buttons.

DF Control Indicator Panels. The plasma panel should indicate when an LOB is being determined so the operator knows that the DF key was activated when he pressed it.

A better means of feedback, such as an increase in resistance, needs to be provided to the operator to indicate when a key has been activated.

Keyboard. A means for changing the resistance of the typewriter keys should be provided to the operator.

Illumination of the keyboard for night operations would be helpful.

Plasma Display. A glare shield should be provided to prevent light from reflecting off the plasma display surface.

Cleaning solvent should be supplied to DF operators so they can clean the plasma display surface in flight if necessary.

Bearing headings should be permanently etched into the periphery of the plasma panel so the DF operator can rapidly provide target direction information to the pilot.

It would be useful to provide a means of entering call signs onto the LOB/EDIT page so that call signs are displayed with their LOB's.

Panoramic Indicator. Inclusion of the panoramic indicator in the DF system should be reconsidered or a change in design be considered. As it is currently configured, DF operators are unable to use it.

The bolts holding the panoramic indicator in place could cause serious injury if an operator were thrown against them in the event of severe turbulence or a crash. It is recommended that an alternate method for restraining the panoramic indicator be devised.

Teleprinter. The teleprinter should be modified by including larger toggle switches and greater spacing between the controls so that operation with gloves is easier.

A paper take-up or cage should be included to prevent the paper printout from blowing around.

Recorder/Reproducer. The recorder/reproducer is difficult to operate with gloves. The controls should be increased in size to conform to Military Standard 1472A and the spacing between the controls be increased.

A means should be provided for ejecting the tape cassette when the operator wishes to change tapes.

A signal should be provided to indicate when tape has run out.

In general, a pushbutton recorder would be more convenient for operators to use.

Workspace and Overall Equipment Configuration. The crew call signal and the master caution signal are not located in a position where they are readily seen when the DF operator is busy. It is recommended that these signals be moved to a position more central to the operator's field of vision. Possibilities include either side of the tuning frequency display, within the plasma display itself, or between the keyboard and the DF key. It would also be helpful to provide an auditory alarm with the visual signal.

The operator's chair should be centered on the keyboard.

The overhead auxiliary communications system control set (C-1611) would be more accessible if it were rotated 90° so that it faced the operator.

The recorder/reproducer would be more convenient if it were relocated in a position just below the tasking board, and the teleprinter could then be moved to where the recorder was and angled toward the DF operator.

A rack for storing tasking sheets, logbooks, and other items should be provided. The rack could be installed on the rack assembly next to the outer wall of the aircraft.

A fire extinguisher is not readily available to operators. A recommended location is on the wall or rack assembly directly behind the DF control box.

First aid kits are not readily accessible to operators. It is recommended that one be located adjacent to the fire extinguisher. It is further recommended that airsickness bags be located with first aid kits.

Cables should be secured to the rack assemblies, rather than left handing loose, so that they will not become entangled in the operators' legs or experience wear and tear of the outer insulation.

Countermeasures System

The overhead auxiliary communications system control set (C-1611) should be rotated 90° so that it faces the operator.

A storage rack for papers, logbooks, and other items should be located on the assembly rack next to the outer wall of the helicopter.

The countermeasures operator's chair should have a greater horizontal adjustment to permit operators to sit closer to the TLQ-27.

The crew call signal and the master caution signal are not located in a position where they are readily seen when the countermeasures operator is busy. A better location for the signals would be on the operator's table just below the TLQ-27.

The ashtray underneath the countermeasures operator's table should be moved from the left side to the right side to prevent bumping and scraping of knees when entering or leaving the countermeasures position.

Navigation System and Countermeasures Antenna Control

Mission Power Control Panel. Switches that are a different shape from those on the cabin heater panel should be used on the mission power control panel to avoid confusion.

Countermeasures Antenna Control. The system should be designed so that pilots can interrupt the flashing of the crew call signal once they have noticed it.

Inertial Navigation System Control Panel. The INS panel needs to be modified so that the lamp in the 10-position thumbwheel switch can be replaced inflight by pilots when it burns out.

The malfunction light should be designed to flash when the INS becomes inoperative.

Overall Equipment Configuration. The locations of the INS panel and the transponder should be switched so that the copilot does not experience vertigo when updating the INS. If this is done, the upper side of the INS panel display face plates should be elevated for easier viewing. Possibly, the yellow lighting in the numeric keys should be changed to red.

The BDHI should be located in a more central position, preferably below the RHAWS indicator or between the copilot's vertical velocity indicator and the transmission oil pressure indicator.

The countermeasures antenna control panel and display would preferably be located together, next to the standby generator load meter.

Environment

A more effective ventilation system should be installed in the aircraft to reduce the possibility of performance degradation on very hot days.

Blackout curtains should be available for snapping over the door windows in order to shut out the sun during the day or for blacking out the aircraft at night.

A blackout curtain should be available for separating the operators' working area from the pilots' working area so that operators can satisfactorily illuminate their equipment at night without interfering with the night vision of pilots.

Operating Procedures and Training

Pilot's clipboards that strap to the leg should be issued to all operators so they can have a stable writing surface for taking notes.

Operators should have separate volume controls for the intercept system and the intercom system in order to avoid uncomfortably loud voice transmissions when switching from one communications system to the other.

Operators should be supplied with fuses so that a simple fuse blow-out does not abort a mission.

An operator's checklist for troubleshooting the system when it malfunctions should be issued.

Operators and pilots should be trained to work together so that pilots can adjust their flight paths for obtaining optimal fixes on a series of targets.

Pilots should be given basic instruction on how the DF system operates so they can fly the best possible flight path for a given series of targets and can help troubleshoot the system when it malfunctions.

The spiral flight pattern should probably be eliminated from the AN/ALQ-151 System Operation Manual.

Explanations of the circuit breaker labels used on the distribution box should be included in the Operator's Manual.

APPENDIX A

QUICK FIX EQUIPMENT DESIGN QUESTIONNAIRE-INTERVIEW

Name: ______________________________ **Date:** ______________________

The purpose of the following questionnaire is to obtain your opinion about the adequacy of the Quick Fix system from an operator's point of view. This will be accomplished by soliciting your answers to a number of questions and by giving you the opportunity to make any additional comments you wish. Take as much time as you feel is necessary to adequately answer the questions. The interviewer will answer any questions you may have and will write down any comments you would like to make about the equipment.

I. Individual Components

A. Using the scale to the right indicate with a check mark (✓) how adequate the plasma display is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. DISPLAY					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Letter discrimination	___	___	___	___	___
e. Information content of LOB/EDIT page	___	___	___	___	___
f. Information precision of LOB/EDIT page	___	___	___	___	___
g. Information content of RCU page	___	___	___	___	___
h. Information precision of RCU page	___	___	___	___	___
i. Information content of MESSAGE page	___	___	___	___	___
j. Information precision of MESSAGE page	___	___	___	___	___
k. Viewing distance	___	___	___	___	___
l. Angle of view	___	___	___	___	___
m. Other (specify)______ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate responses:

B. Using the scale to the right indicate with a check mark (✓) how adequate the panoramic indicator is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. DISPLAY					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Information content	___	___	___	___	___
e. Information precision	___	___	___	___	___
f. Method of presenting information	___	___	___	___	___
g. Viewing distance	___	___	___	___	___
h. Angle of view	___	___	___	___	___
i. Other (specify)______ ________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

C. Using the scale to the right indicate with a check mark (✓) how adequate the <u>receiver control panel</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. TUNING FREQUENCY DISPLAY					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Viewing distance	___	___	___	___	___
e. Angle of view	___	___	___	___	___
f. Correct labels	___	___	___	___	___
g. Other (specify)______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

D. Using the scale to the right indicate with a check mark (✓) how adequate the DF control-indicator is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)________ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate answers:

E. Using the scale to the right indicate with a check mark (✓) how adequate the <u>status control-indicator</u> is in each of the following areas:	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. DISPLAY					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Viewing distance	___	___	___	___	___
e. Angle of view	___	___	___	___	___
f. Correct labels	___	___	___	___	___
g. Other (specify)______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

F. Using the scale to the right indicate with a check mark (✓) how adequate the <u>keyborad-transmitter</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate answers:

6. Using the scale to the right indicate with a check mark (✓) how adequate the transceiver is in each of the following areas:	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate answers:

H. Using the scale to the right indicate with a check mark (✓) how adequate the <u>indicator panel</u> is in each of the following areas:	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CAUTION PANEL					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Viewing distance	___	___	___	___	___
e. Angle of view	___	___	___	___	___
f. Correct labels	___	___	___	___	___
g. Other (specify)______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

I. Using the scale to the right indicate with a check mark (✓) how adequate the <u>distribution</u> <u>box</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate answers:

J. Using the scale to the right indicate with a check mark (✓) how adequate the recorder/reproducer is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. METER					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Viewing distance	___	___	___	___	___
e. Angle of view	___	___	___	___	___
f. Correct labels	___	___	___	___	___
g. Other (specify)_______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)_______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

K. Using the scale to the right indicate with a check mark (✓) how adequate the <u>teleprinter</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. PRINTED COPY					
a. Readability	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3))	(4)	(5)
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

II. Workspace

A. Using the scale to the right indicate with a check mark (✓) how adequate the workspace in the Quick Fix is for each of the following factors:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. Leg room	___	___	___	___	___
2. Elbow room	___	___	___	___	___
3. Seating					
a. Horizontal adjustment	___	___	___	___	___
b. Vertical adjustment	___	___	___	___	___
c. Backrest	___	___	___	___	___
d. Cushioning	___	___	___	___	___
4. Storage room (for papers, personal items, etc.)	___	___	___	___	___
5. Other (specify)______ ____________________.	___	___	___	___	___

6. Please explain any Borderline, Inadequate, or Very Inadequate responses:

B. I would like you to take a few minutes now to consider the overall configuration of the Quick Fix intercept and DF System. Based on your experience with the system, could the system be made more efficient and easier to use by arranging the components in a different way? If so, how would you arrange them? (Please support your answer).

III. Environment

Using the scale to the right indicate with a check mark (✓) how adequate the environmental conditions in your work workspace are:

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
1. Temperature	___	___	___	___	___
2. Ventilation	___	___	___	___	___
3. Noise	___	___	___	___	___
4. Vibration	___	___	___	___	___
5. Illumination	___	___	___	___	___
6. Other (specify)______ ____________________.	___	___	___	___	___

IV. Safety

Indicate with a check mark (√) if any of the hazards listed to the right exist for the following controls and indicators (please explain your answers).	Electrical Hazard (1)	Heat Hazard (2)	Structural Hazard (sharp edges, entangling) (3)	Mechanical Hazard (moving parts) (4)	Extreme brightness (5)	Extreme loudness (6)
1. Plasma display	___	___	___	___	___	___
2. Panoramic indicator	___	___	___	___	___	___
3. Receiver control	___	___	___	___	___	___
4. DF control-indicator	___	___	___	___	___	___
5. Status control indicator	___	___	___	___	___	___
6. Keyboard-transmitter	___	___	___	___	___	___
7. Transceiver	___	___	___	___	___	___
8. Indicator panel	___	___	___	___	___	___
9. Distribution box	___	___	___	___	___	___
10. Recorder/reproducer	___	___	___	___	___	___
11. Teleprinter	___	___	___	___	___	___
12. DF control box	___	___	___	___	___	___
13. DF intercept box	___	___	___	___	___	___
14. Cables	___	___	___	___	___	___
15. Chair	___	___	___	___	___	___
16. Metal framework	___	___	___	___	___	___
17. Other (specify)______ ____________________.	___	___	___	___	___	___

18. Please list any other safety hazards.

APPENDIX B

QUICK FIX FOLLOW-ON QUESTIONNAIRE-INTERVIEW FOR OPERATORS

Name: ______________________________ Date: ______________________

The purpose of the following questionnaire is to obtain your opinion about the adequacy of aspects of the Quick Fix system that were not covered in the previous questionnaire. This will be accomplished by soliciting your answers to a number of questions and by giving you the opportunity to make any additional comments you wish. Take as much time as you feel is necessary to adequately answer the questions. The interviewer will answer any questions you may have and will write down any comments you would like to make.

I. Countermeasures Position Components

A. Using the scale to the right indicate with a check mark (✓) how adequate the jammer's <u>indicator panel</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CAUTION PANEL					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Viewing distance	___	___	___	___	___
e. Angle of view	___	___	___	___	___
f. Correct labels	___	___	___	___	___
g. Other (specify) ______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)________ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

II. Countermeasures Position Workspace

A. Using the scale to the right indicate with a check mark (✓) how adequate the workspace in the Quick Fix is for each of the following factors:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. Leg room	___	___	___	___	___
2. Elbow room	___	___	___	___	___
3. Seating					
a. Horizontal adjustment	___	___	___	___	___
b. Vertical adjustment	___	___	___	___	___
c. Backrest	___	___	___	___	___
d. Cushioning	___	___	___	___	___
4. Storage room (for papers, personal items, etc.)	___	___	___	___	___
5. Other (specify)______ ____________________.	___	___	___	___	___

6. Please explain any Borderline, Inadequate, or Very Inadequate responses:

B. I would like you to take a few minutes now to consider the overall configuration of the Quick Fix jamming system. Based on your experience with the system, could the system be made more efficient and easier to use by arranging the components in a different way? If so, how would you arrange them? (Please support your answer).

III. Safety of Countermeasures Position

Indicate with a check mark (✓) if any of the hazards listed to the right exist for the following controls and indicators (please explain your answers).

	Electrical Hazard (1)	Heat Hazard (2)	Structural Hazard (sharp edges, entangling) (3)	Mechanical Hazard (moving parts) (4)	Extreme Brightness (5)	Extreme Loudness (6)
1. Indicator panel	___	___	___	___	___	___
2. Countermeasures set	___	___	___	___	___	___
3. Cables	___	___	___	___	___	___
4. Chair	___	___	___	___	___	___
5. Metal framework	___	___	___	___	___	___
6. Other (specify) ________ ______________________.	___	___	___	___	___	___

7. Please list any other safety hazards.

IV. Operating Porcedures

Listed below is an outline of the activities of a Quick Fix DF operator and countermeasures operator. Please explain any serious problems you have encountered in conducting these procedures.

DF POSITION

I. System start up.

II. BITE test

III. System operation

A. Enter frequencies

B. Scan or step through frequencies

1. Listen
2. Observe panoramic indicator

C. Take LOB's (DF) and store LOB's

D. Fix targets

E. Type gist

F. Record messages on recorder

G. React to caution lights

H. Communicate

1. with pilot/copilot
2. with countermeasures operator
3. with ground/operations center

IV. System shut down

COUNTERMEASURES POSITION

I. System start up.

II. System operations

A. Jam targets

B. React to caution lights

C. Communicate

1. with pilot/copilot
2. with DF operator
3. with ground/operations center

III. System shut down

V. Training

A. How many hours have you spent operating the Quick Fix system?

_____ hours in DF position

_____ hours in Countermeasures position

B. Please describe the formal training you received on the Quick Fix system.

Dates	Location	No. of Hrs. of training	Description of training

C. What manuals, if any, for the Quick Fix system have you used? Please list them and rate them in terms of their usefulness to you.

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. ____________	___	___	___	___	___
2. ____________	___	___	___	___	___
3. ____________	___	___	___	___	___
4. ____________	___	___	___	___	___
5. ____________	___	___	___	___	___

Please explain any Borderline, Inadequate, or Very Inadequate answers.

D. Are there any parts of the Quick Fix system or procedures used in operating the Quick Fix system which you feel should receive special emphasis in developing a formal training program for Quick Fix operators?

APPENDIX C

QUICK FIX EQUIPMENT DESIGN QUESTIONNAIRE-INTERVIEW FOR PILOTS AND COPILOTS

Name: ______________________________ Date: ______________________

The purpose of the following questionnaire is to obtain your opinion about the adequacy of the Quick Fix system from a pilot-copilot's point of view. This will be accomplished by soliciting your answers to a number of questions and by giving you the opportunity to make any additional comments you wish. Take as much time as you feel is necessary to adequately answer the questions. The interviewer will answer any questions you may have and will write down any comments you would like to make about the equipment.

I. Individual Components

A. Using the scale to the right indicate with a check mark (✓) how adequate the INS panel is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. DISPLAY					
a. Display brightness	___	___	___	___	___
b. Absence of glare	___	___	___	___	___
c. Absence of flicker	___	___	___	___	___
d. Information content	___	___	___	___	___
e. Information precision	___	___	___	___	___
f. Method of presenting information	___	___	___	___	___
g. Viewing distance	___	___	___	___	___
h. Angle of view	___	___	___	___	___
i. Other (specify)______ ____________________.	___	___	___	___	___
2. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

B. Using the scale to the right indicate with a check mark (✓) how adequate the <u>mission power control panel</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate	Adequate	Borderline	Inadequate	Very Inadequate
	(1)	(2)	(3)	(4)	(5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

3. Please explain any Borderline, Inadequate, or Very Inadequate answers:

C. Using the scale to the right indicate with a check mark (✓) how adequate the active countermeasures group, antenna control is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. CONTROLS					
a. Size (without gloves)	___	___	___	___	___
b. Size (with gloves)	___	___	___	___	___
c. Shape (without gloves)	___	___	___	___	___
d. Shape (with gloves)	___	___	___	___	___
e. Spacing between controls (without gloves)	___	___	___	___	___
f. Spacing between controls (with gloves)	___	___	___	___	___
g. Resistance (too easy to turn or push, or too hard to turn or push)	___	___	___	___	___
h. Correct labels	___	___	___	___	___
i. Understandable labels	___	___	___	___	___
j. Size of labels	___	___	___	___	___
k. Location of labels	___	___	___	___	___
l. Absence of unrelated or confusing markings	___	___	___	___	___

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
m. Visibility of controls	___	___	___	___	___
n. Angle of view	___	___	___	___	___
o. Location of critical controls	___	___	___	___	___
p. Reach distance of critical controls	___	___	___	___	___
q. Location of noncritical controls	___	___	___	___	___
r. Reach distance of noncritical controls	___	___	___	___	___
s. Functional grouping (controls with related functions are grouped together)	___	___	___	___	___
t. Control type (type of control is appropriate for type of function)	___	___	___	___	___
u. Other (specify)______ ____________________.	___	___	___	___	___

2. Please explain any Borderline, Inadequate, or Very Inadequate answers:

D. Using the scale to the right indicate with a check mark (✓) how adequate the <u>bearing-distance-heading indicator</u> is in each of the following areas:

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. Brightness	___	___	___	___	___
2. Absence of glare	___	___	___	___	___
3. Information content	___	___	___	___	___
4. Information precision	___	___	___	___	___
5. Method of presenting information	___	___	___	___	___
6. Viewing distance	___	___	___	___	___
7. Angle of view	___	___	___	___	___
8. Other (specify) ______ ____________________.	___	___	___	___	___

9. Please explain any Borderline, Inadequate, or Very Inadequate answers:

II. Overall Equipment Configuration

I would like you now to consider the location of the Quick Fix components you must work with as a pilot or copilot. Could relocating these components enhance your ability to use them? If so, where would you locate them? Also, are there any components you don't need, or are there some you need but don't have? (Please support your answer).

III. Safety

Indicate with a check mark (✓) if any of the hazards listed to the right exist for the following controls and indicators (please explain your answers).

	Electrical Hazard	Heat Hazard	Structural Hazard (sharp edges, entangling)	Mechanical Hazard (moving parts)	Extreme Brightness	Extreme Loudness
	(1)	(2)	(3)	(4)	(5)	(6)
1. INS	___	___	___	___	___	___
2. Mission power control panel	___	___	___	___	___	___
3. Active countermeasures group, antenna control	___	___	___	___	___	___
4. Bearing-distance-heading indicator	___	___	___	___	___	___
5. Other (specify) ______ ______________________.	___	___	___	___	___	___

6. Please list any other safety hazards.

IV. Operating Procedures

Please explain any problems in operating the Quick Fix system and aircraft with respect to the following areas. Also indicate how the problem might be corrected.

A. Inflight communication and coordination between pilot and DF operator.

B. Inflight communication and coordination between copilot and DF operator.

C. Inflight communication and coordination between pilot and jammer.

D. Inflight communication and coordination between copilot and jammer.

E. Inflight communication and coordination between pilot and copilot.

F. Safety hazards.

G. Other.

V. Training

A. How many hours have you spent operating the Quick Fix aircraft?

_____ hours as pilot.

_____ hours as copilot.

B. Please describe the formal training you received on the Quick Fix aircraft.

Dates	Location	No. of Hrs. of training	Description of training

C. What manuals, if any, for the Quick Fix system and/or aircraft have you used? Please list them and rate them in terms of their usefulness to you as a Quick Fix pilot.

	Very Adequate (1)	Adequate (2)	Borderline (3)	Inadequate (4)	Very Inadequate (5)
1. ______________	___	___	___	___	___
2. ______________	___	___	___	___	___
3. ______________	___	___	___	___	___
4. ______________	___	___	___	___	___
5. ______________	___	___	___	___	___

Please explain any Borderline, Inadequate, or Very Inadequate answers.

D. Please indicate any procedures or pieces of equipment on which, in your opinion, pilots of the Quick Fix aircraft should receive formal training. (Please support your answer).

APPENDIX D

LISTS OF FREQUENCIES, TYPES OF GAIN CONTROL, TYPES OF MODULATION, AND BANDWIDTHS ENTERED INTO THE RCU

LIST 1

THE OPERATIONS CENTER IS ABOUT TO INFORM YOU OF A SERIES OF FREQUENCIES WHICH THEY WANT YOU TO DF. YOU WILL BE TOLD THE FREQUENCY, TYPE OF GAIN CONTROL, TYPE OF MODULATION, AND BANDWIDTH TO ENTER. ENTER EACH ONE AS IT IS GIVEN TO YOU. IF YOU MAKE AN ERROR, SIMPLY SAY "ERROR" OUT LOUD BUT DO NOT CORRECT IT. READY?

1.	42.973 ___	AGC ___	FM ___	50K ___
2.	24.937 ___	LMGC ___	CW ___	8K ___
3.	25.403 ___	MGC ___	AM ___	30K ___
4.	61.837 ___	LMGC ___	FM ___	50K ___
5.	49.716 ___	AGC ___	FM ___	30K ___
6.	38.406 ___	MGC ___	AM ___	8K ___
7.	73.492 ___	MGC ___	FM ___	50K ___
8.	59.617 ___	LMGC ___	FM ___	50K ___
9.	29.438 ___	MGC ___	AM ___	8K ___
10.	34.918 ___	AGC ___	AM ___	30K ___

TIME: _____MIN. ______SEC.

OPERATOR ____________________

LIST 2

THE OPERATIONS CENTER IS ABOUT TO INFORM YOU OF A SERIES OF FREQUENCIES WHICH THEY WANT YOU TO DF. YOU WILL BE TOLD THE FREQUENCY, TYPE OF GAIN CONTROL, TYPE OF MODULATION, AND BANDWIDTH TO ENTER. ENTER EACH ONE AS IT IS GIVEN TO YOU. IF YOU MAKE AN ERROR, SIMPLY SAY "ERROR" OUT LOUD BUT DO NOT CORRECT IT. READY?

1.	27.619 ___	LMGC ___	AM ___	30K ___
2.	46.819 ___	AGC ___	FM ___	50K ___
3.	76.183 ___	MGC ___	FM ___	30K ___
4.	37.806 ___	AGC ___	AM ___	8K ___
5.	57.943 ___	LMGC ___	FM ___	50K ___
6.	26.713 ___	MGC ___	CW ___	8K ___
7.	30.791 ___	MGC ___	AM ___	30K ___
8.	67.483 ___	LMGC ___	FM ___	50K ___
9.	48.706 ___	AGC ___	FM ___	50K ___
10.	29.816 ___	MGC ___	AM ___	8K ___

TIME: _____MIN. ___SEC.

OPERATOR ____________________

LIST 3

THE OPERATIONS CENTER IS ABOUT TO INFORM YOU OF A SERIES OF FREQUENCIES WHICH THEY WANT YOU TO DF. YOU WILL BE TOLD THE FREQUENCY, TYPE OF GAIN CONTROL, TYPE OF MODULATION, AND BANDWIDTH TO ENTER. ENTER EACH ONE AS IT IS GIVEN TO YOU. IF YOU MAKE AN ERROR, SIMPLY SAY "ERROR" OUT LOUD BUT DO NOT CORRECT IT. READY?

1.	34.918 ___	AGC ___	AM ___	30K ___
2.	29.438 ___	MGC ___	AM ___	8K ___
3.	59.617 ___	LMGC ___	FM ___	50K ___
4.	73.492 ___	MGC ___	FM ___	50K ___
5.	38.406 ___	MGC ___	AM ___	8K ___
6.	49.716 ___	AGC ___	FM ___	30K ___
7.	61.837 ___	LMGC ___	FM ___	50K ___
8.	25.403 ___	MGC ___	AM ___	30K ___
9.	24.937 ___	LMGC ___	CW ___	8K ___
10.	42.973 ___	AGC ___	FM ___	50K ___

TIME: _____MIN. _____SEC.

OPERATOR ____________________

LIST 4

THE OPERATIONS CENTER IS ABOUT TO INFORM YOU OF A SERIES OF FREQUENCIES WHICH THEY WANT YOU TO DF. YOU WILL BE TOLD THE FREQUENCY, TYPE OF GAIN CONTROL, TYPE OF MODULATION, AND BANDWIDTH TO ENTER. ENTER EACH ONE AS IT IS GIVEN TO YOU. IF YOU MAKE AN ERROR, SIMPLY SAY "ERROR" OUT LOUD BUT DO NOT CORRECT IT. READY?

1.	29.816 ___	MGC ___	AM ___	8K ___
2.	48.706 ___	AGC ___	FM ___	50K ___
3.	67.483 ___	LMGC ___	FM ___	50K ___
4.	30.791 ___	MGC ___	AM ___	30K ___
5.	26.713 ___	MGC ___	CW ___	8K ___
6.	57.943 ___	LMGC ___	FM ___	50K ___
7.	37.806 ___	AGC ___	AM ___	8K ___
8.	76.183 ___	MGC ___	FM ___	30K ___
9.	46.819 ___	AGC ___	FM ___	50K ___
10.	27.619 ___	LMGC ___	AM ___	30K ___

TIME: _____MIN. _____SEC.

OPERATOR ________________

APPENDIX E

MESSAGES ENTERED INTO THE KEYBOARD

Enter the following message on your gist page, typing at a speed that you are used to. Try not to make errors, but if you do make any errors do not correct them.

Time: ____min. ____sec.

Message Number ________

Operator - ____________

MESSAGE NUMBER 1. THE COMMUNICATION INTERCEPTED ON 27.631 REVEALS THAT A TANK BATTALION IS ON ITS WAY TO REINFORCE BLUEBIRD 6. IT IS EXPECTED TO ARRIVE AT 1600 HOURS AND TAKE UP A DEFENSIVE POSITION 2 KILOMETERS WEST OF GREEN MOUNTAIN. BLUEBIRD 6 IS RUNNING LOW ON ARTILLERY AMMO AND WILL NOT BE RESUPPLIED TODAY. CASUALTIES HAVE BEEN HIGH AND TROOP STRENGTH IS VERY LOW.

MESSAGE NUMBER 2. INTERCEPTION OF 35.942 SHOWS THAT RED FOX 4 IS PREPARING FOR AN ATTACK ALONG YELLOW RIVER. UNITS WILL BEGIN MASSING AT 0100 HOURS AND WILL CROSS THE RIVER AT 0600 HOURS. THE OPERATION IS EXPECTING TO RECEIVE STRONG AIR SUPPORT AND BE REINFORCED BY AN INFANTRY REGIMENT. PRIMARY OBJECTIVES INCLUDE ROUND TOP HILL, NORTHWEST MOUNTAIN, AND LONGVIEW BRIDGE.

MESSAGE NUMBER 3. COMMUNICATIONS ON 46.197 INDICATE THAT BLACK DOG 5 IS RUNNING OUT OF AMMO AND RATIONS. IT IS PREPARING A DELAYED WITHDRAWAL TO BEGIN AT 1700 HOURS. UNITS WILL FALL BACK TO POSITIONS ALONG DEEP CUT PASS WHERE THEY WILL BE REINFORCED BY AN AIR DEFENSE UNIT. CASUALTIES ARE HIGH AND THE UNITS EXPECT REPLACEMENTS SOON AFTER TAKING UP THEIR NEW POSITIONS.

MESSAGE NUMBER 4. COMMO TRAFFIC ON 51.437 REVEALS THAT WHITE HORSE 3 IS PLANNING AN ATTACK AT 0500 HOURS. IT WILL BE REINFORCED WITH 2 ARTILLERY BATTERIES AND WILL ATTEMPT TO SEIZE RAINBOW HILL, BLUE RIDGE, AND TALL MOUNTAIN. IT IS WELL SUPPLIED WITH AMMO AND EXPECTS LITTLE RESISTANCE FROM FRIENDLY FORCES. AIR SUPPORT WILL BE MINIMAL AND FEW CASUALTIES ARE EXPECTED.